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Abstract

Existing studies of cost growth in defense acquisition have been predominantly descriptive rather than explanatory. However, recent studies have highlighted the importance of decision-making by government officials as a factor affecting cost growth. While observers of defense acquisition acknowledge the role of social, cultural and institutional factors on program performance, few studies are focused there. Thus, informed by the literatures on cost growth, behavioral finance, group decision-making, and organizational failure, a research agenda is developed to consider factors affecting cost growth beyond those traditionally studied. Ostrom's Institutional Analysis and Development framework can be the foundation of a stream of research including both field studies and laboratory/computational experiments that may provide fresh insights into the cost growth phenomenon and—more importantly—aid in the design of more effective policy interventions.

Keywords

defense acquisition, cost growth, institutionalism, policy intervention, military sociology

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Introduction

The US defense department suffers from persistent, but not certain, cost growth within major acquisition programs. Over the past few decades, scores of studies have looked at factors such as the size of the program, its phase in the development cycle, the type of weapon being purchased and organizational structure. Other studies have taken a more qualitative view—considering the interplay of actions within a program office and between a program office and its environment. Both types of studies have provided countless recommendations to fix defense acquisition. Yet, problems persist. Twenty-first century shipbuilding, for example, suffers some of the same challenges described in Ian Toll's account of building the 18th century navy in his book, *Six Frigates*[1]: rising material costs, labor shortages, inaccurate estimates, unproven technologies, requirements creep, decisions based on politics instead of economics or national security, reduced procurement quantities, sliding schedules, and occasional mismanagement. As the studies show, those factors often result in cost growth. Given the materiality of the problem (i.e., hundreds of billions of dollars), the number of times it has been studied, the attention of the highest levels of government, and the myriad rules that have resulted in attempts to reform acquisition, two questions remain: Why does the problem persist? What have the studies and policy prescriptions missed?

In search of an answer, I propose a fresh line of research that combines field work with laboratory and computation experimentation employing a framework that considers

variables beyond those traditionally used. Through a mutually supportive set of studies that combine the realism of field studies with the ability to rigorously test hypotheses through models in computational and laboratory experiment policy makers may gain fresh insights on the problem to craft more effective policy interventions. I assert that cost growth ultimately results from a series of decisions and until policy-makers sufficiently understand the institutional factors affecting decision-makers, they cannot craft effective policies to improve those decisions.

Theoretical Foundation

Before the McCain-Levin "Weapons Systems Acquisition Reform Act of 2009" (S.454) was introduced in February of 2009, the Government Accountability Office (GAO) assessed the likely efficacy of the proposed reforms and concluded, "Our discussions with acquisition experts indicate that these changes may not achieve the desired improvement in acquisition outcomes unless they are accompanied by changes in the overall acquisition environment, its culture, and the incentives provided for success."[2] Two things are important to note: first, the environment, culture and incentives are salient moderating factors; second, acquisition experts already know about such factors. Interestingly, those factors have not been adequately addressed in cost growth studies.

The fact such factors have been ignored is not very surprising. The military tends to view problems through a quantitative, rational, and technical perspective. As the Fall 2008 special issue of Armed Forces & Society on sociology in the military academies noted, military academies were founded on need for technical education, they still stress technical education over all other (quote from Gates or Winter here), social sciences are relatively new to the curricula and tend to focus on developing a cadet's leadership skills or understanding

small group behavior.[3] While the social dimensions of potential adversaries may be studied, rarely does the U.S. military examine itself through a sociological lens. One exception noted by Segal and Ender is in topics such as "diversity, personnel issues and the demographics of the forces."[4] But there remains a lack of knowledge concerning the management of the Defense Department that social sciences can begin to fill.

Cost Growth

Scores of studies over the past two to three decades have taught us much about cost growth. Studies have examined whether the size of a program is germane.[5] They have studied growth within the categories of Selected Acquisition Reports such as estimating errors, inflation, and engineering changes.[6] Studies have looked at differences in cost growth across types of weapons systems.[7] Other studies have looked at the point in the development cycle when cost growth tends to occur,[8] organizational structural issues such as reporting relationships,[9] centralization of authority,[10] and knowledge flows[11] have also been considered.

Extant cost studies have been overwhelmingly descriptive rather than explanatory. Knowing that more growth occurs during R&D than production is helpful but does not explain why. Knowing that aircraft programs suffer more growth than missile programs may suggest more management attention be placed there, yet that knowledge has not improved outcomes. With few exceptions, studies of cost growth in defense acquisition have adopted the foundational assumptions of economics or systems engineering so when the analyst approaches the political, institutional, social, or psychological dimensions of the problem, those issues are assumed away, defined as outside the bounds of the study, or left for further research. When the social issues have a salient effect on the conclusions, they are addressed

but not sufficiently analyzed. A notable example is the 2006 Defense Acquisition Performance Assessment (DAPA) Report, which asserts a "conspiracy of hope" among the actors in acquisition.[12]

Two recent studies, however, have taken a slightly different approach to the cost growth phenomenon and offer new insights. RAND looked beyond the traditional cost categorization studies in an attempt to understand underlying causes.[13] The authors abandoned the Selected Acquisition Report taxonomy and analyzed the supporting documentation to determine underlying causes of the cost growth. They found that two-thirds of cost growth could be attributed to decisions made by government officials. Those decisions concerned questions of affordability, and changes to resources, quantities, requirements and schedules. Their report provides an important insight, but while the study identified the content of decisions its research design could not answer why those decisions were made and under what conditions could better decisions could be made. The research agenda proposed here could address those issues.

The second study considered projects outside the defense establishment. Flyvbjerg and his colleagues examined cost growth in public works projects and identified psychological and institutional biases in the estimates and decisions to fund the projects.[14] They noted two forms of bias: psychological biases of the type explained in the work of Kahneman and Tversky (to be considered below), and political biases. Flyvbjerg charged that officials misrepresented project costs in an effort to seek approval of the projects. That is, they deliberately presented underestimates of the cost of the project. Flyvbjerg uses the term "strategic misrepresentation," a term previously used in studies of public budgeting.[15] Jones and Euske note that strategic misrepresentation "is a contingent strategy responsive to a

system of rewards in a highly competitive game where resource constraints are present."[16] The word "strategic" is important to consider here. These officials are making a deliberate decision to lie because they believe it is an appropriate strategy given their context and perceived payoff.

Decision-making Behavior

There are two literatures regarding decision-making that pertain to the issue at hand. The first concerns the non-rational behavior commonly and consistently found when people make financial decisions. The works of Daniel Kahneman and Amos Tversky, as well as Dick Thaler are germane. The second literature concerns group decision-making processes, and the works of Herb Simon, Jim March and Bryan Jones are germane.

Kahneman and Tversky's prospect theory[17] provides a descriptive view of human decision-making that consistently and predictably deviates from the rational utility-maximizing assumptions of many economic models. Likewise, Thaler's mental accounting research demonstrates that people categorize and evaluate financial events in a manner that defies the assumption of fungibility of money. Financial events are believed to have both acquisition value (the value of the money involved) and transaction value (the emotional value of the event—the "good deal"),[18] and such mental accounting results in non-rational behavior and sub-optimal outcomes. From Kahneman and Tversky and Thaler, we know that actual financial decision-making often defies the tidy logic of conventional economic studies. Since human nature is predictably non-rational, policy interventions can be designed to exploit those tendencies. Such is the point of Thaler and Sunstein's recent bestseller, *Nudge*.[19] There is no reason to believe decision-making related to defense acquisition is immune from such tendencies.

Not only are individuals prone to non-rational decisions regarding financial matters, they are also boundedly rational. That is, the assumption of perfect information common in economic models—all relevant information is available, there is infinite information processing capability, and decision-maker preferences are self-interested, known, and stable—are relaxed based on the knowledge that such assumptions simply are not true. Decision-makers do not have all available information: they have limited attention spans and processing capabilities, their desires are not necessarily stable, and they often act in the interest of others, even altruistically. In his work on organizational decision-making, March advances the idea that in certain contexts a good decision is measured not by the outcome but by the appropriateness of the decision. Decisions are made not through a logic of rational choice or a logic of consequences but through rule-following and the pairing of an understanding of appropriateness to the specifics of the situation.[20] Often in public administration, appropriateness is paramount. Means become ends in themselves. What others think about one's actions cannot be so easily dismissed, as evidenced by ethics rules concerning the "mere perception of impropriety." Appropriateness adds a moral dimension to decision-making that utility maximization does not thereby affecting the criteria by which decisions are made, the perceived payoffs of alternative decisions, and the information gathered and considered. In group decision-making situations, especially when members of the group represent different sets of values, there are inconsistencies in decision criteria, power struggles, coalitions, and compromises.[21]

Bryan Jones applied bounded rationality concepts to decision-making in public policy. He finds policy makers must access and interpret information from their environments in order to take action. The information is filtered due to capacity and

cognitive limitations and only the most salient information is attended to, but salience depends on the individual decision-makers, their experience, heuristics, and the roles they play. The quality of the interpretation of the information is a function of knowledge, cognitive abilities, and biases. Any two individuals confronted with the same information, in the same context, will not necessarily act similarly. The differences are likely to be more pronounced when the volume of information increases, the complexity or uncertainty of means-ends causal chains increases, the various institutional forces are ambiguous or contradictory, and if there are repeated decisions in a recurring process.[22]

At this point it is vital to ask whether defense acquisition is characterized by such boundedly rational, heterogeneous decision-makers and could that contribute to cost growth? Apparently so. A recent GAO report concluded, "The uniqueness of each program, the lack of sufficient knowledge about system requirements, technology and design maturity, and the limited analytical tools available are often cited as factors that contribute to optimistic forecasts of development costs."[23]

Persistent Failure in Organizations

In addition to the limitations of past cost growth studies and the nature of group decision-making, a third influence on this study is the literature regarding persistently failing organizations. By one definition, such organizations are those in which the official goals of sponsors or owners are not accomplished.[24] Cost growth in defense acquisition meets that definition. The Marine Corps Expeditionary Fighting Vehicle has been in development for over 20 years, consumed billions of dollars, but has yet to field a single acceptable vehicle.[25] Meyer and Zucker wondered how it could be that an organization survives for many years despite failing to meet prescribed goals. Using a broad approach employing social movement

theory, strategic management, agency theory, and transaction costs, they concluded that an organization's performance need not determine its survival, provided there are sufficiently powerful actors whose interests are served more by the presence of the organization than its performance.[26] It is reasonable to expect a similar dynamic affects certain acquisition programs and the pattern of behaviors described by Meyer and Zucker may be present in troubled defense acquisition programs.

Bissell's study of public bureaucracy failure—not unlike past studies of defense acquisition—notes a tendency to overlook the socio-cultural elements of government work. His study cites a tendency to adopt technocratic and rationalist perspectives when debating policy, while "failing to consider the conflicts, contradictions, and counter-intuitive outcomes that are inherent in planning in complex situations."[27]

Gailey and Lee studied the assignment of blame for deviance in organizations through a sociological perspective. They suggest that studying deviance – and cost growth is a form of deviance – includes both an examination of the intent of actors and the selection of an appropriate level of analysis.[28] Culture is said to be the mediating mechanism between macro levels (i.e., societal, constitutional), meso levels (i.e., organizational, policy) and micro levels (i.e., individual, operational) of analysis.[29] That is, human behavior is situated along, and is affected by, considerations at all levels.[30] Cultural norms and beliefs determine appropriateness and may normalize deviant actions: "culture redefines deviance so that it appears to be conformity."[31] For example, examinations of the Challenger space shuttle disaster and the Tuskegee syphilis studies reveal cultural orientations of technical rationality and routinization of operations lead to a moral blindness in business decisions. In such situations, achieving a technical solution can become paramount, and the associated social

costs are undervalued. Resolving deviance in an organizational context requires remedies that affect the culture and not solely the behavior.[32]

In an attempt to understand the multi-layered cultural influences on organizational failure, Collier drew on the Institutional Analysis and Development framework of Elinor Ostrom and her colleagues in a study of corruption. Like cost growth in acquisition, corruption is a form of organizational failure that diverts resources from more beneficial uses, distracts attention, and ultimately affects the security of the state. Like defense acquisition, corruption had been studied at length, without considering the interplay of economic, cultural and political forces. Ostrom's framework enabled Collier "to combine several seemingly unrelated theories of political, economic, and cultural behaviors into one interdisciplinary social theory."[33] He was able to offer a mid-level theoretical explanation of corruption and to identify several social phenomena that warrant further study on an individual and interactive basis. He also identified reasons why it is so difficult to uproot corruption. Inspired by Collier's work, this paper suggests a similar path to understanding cost growth in defense acquisition.

Integrating these literatures, it is apparent that perfectly rational decision-makers who always seek to obtain the optimal outcome as decided by competent authority are lacking; rather, boundedly rational people making decisions that are sometimes goal-seeking and sometimes appropriate are prevalent. Decisions about financial matters are prone to known biases that very well may affect the quality of decisions about defense budget allocations. The decisions reflect strategies affected by explicitly understood organizational rules and implicitly understood institutional norms and customs. In certain contexts, those rules, norms and customs are well aligned and the organization (here, an acquisition program) achieves a

successful outcome. In other contexts, the rules, norms and customs may have created an environment in which cost growth becomes acceptable or inevitable. A conscious (or unconscious) "conspiracy of hope" ensues and the program fails to achieve a major goal. The remedy for such a problem cannot be found solely in rational, technical approaches but must attend to the social and institutional factors.

A Promising Framework

How does one, then, seek to understand this relationship between the decision makers, the organization, its context, and institutional cultural concerns? As Frederickson and Smith stated, "in simplified form, institutionalism sees organizations as bounded social constructs of rules, roles, norms, and the expectations that constrain individual and group choice and behavior."[34] Ostrom's Institutional Analysis and Development (IAD) framework (used by Collier in his study of corruption) is appropriate for analyzing these influences on defense acquisition outcomes.

The IAD framework assumes that all social interactions can be viewed as composed of the same set of elements, whether they are economic markets, political organs, community or fraternal groups, hierarchical organizations, or sporting events. The IAD framework neatly mirrors the variables commonly used in game theory and organizational simulations[35] thereby allowing a researcher to perform structured exploratory and grounded research in the field and then to bring those findings into a laboratory or computational setting for hypothesis testing. Figure 1 summarizes the elements of the framework.

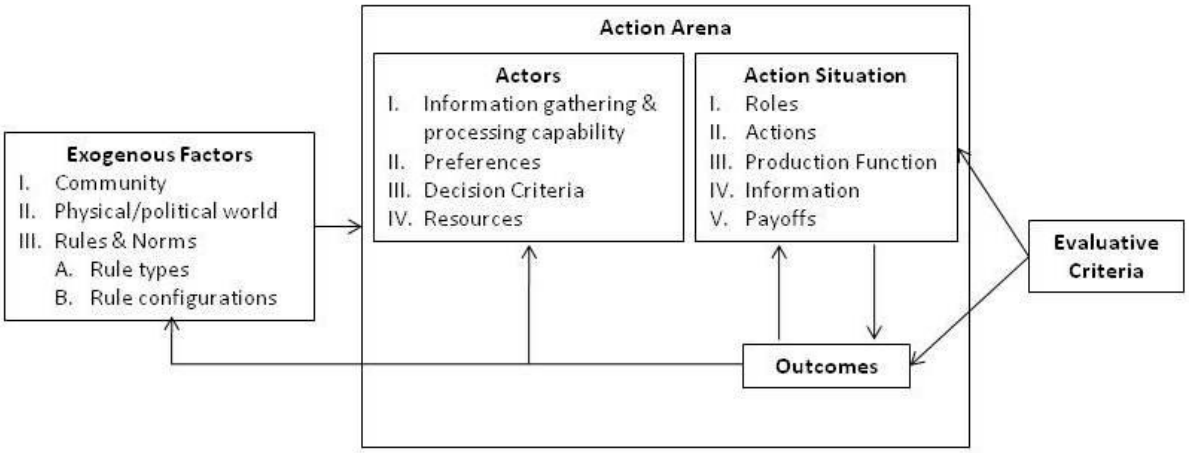

Figure 1. The IAD Framework

The focal point of the framework is the action arena, which consists of actors who interact in an action situation, affected by exogenous factors, and the resultant outcomes. The action situation consists of five elements: the roles played by the actors, their actions, a production function that links actions to outcomes, information, and payoffs. An example of an action arena in defense acquisition is the decision process for determining how many of an item to procure in the next budget and the requisite amount of funding. It should be noted that in a complex action situation, an actor may serve in more than one role, and actors normally serve in several roles across different action arenas. Within those roles, actors act and rules define the possible and appropriate actions. Depending on the level of analysis, the actors can be an individual, a group of individuals, or a social construct such as an organization or social system. There is a body of information available to all actors in the action arena, should they choose to access it. Actors are characterized, in part, by their individual ability to gather and process information. The interplay of actions by the actors results in some outcome that has an associated payoff for each actor. The ex ante expectation of a payoff affects the strategies employed by actors; the ex post realization of payoffs is information that may influence strategies if there are subsequent occurrences of the action

situation. The outcome is evaluated according to some criteria on an individual or collective basis. In acquisition, the obvious outcome is the fielding of a new military capability, which the commander in the field contends is success, but if that system cost 25% more than planned the budget office may view that as failure. Action situations may occur once, a defined number of times, or an indefinite number of times. Repeated situations have bearing on strategies employed by actors, information flows, outcomes and payoffs. An action situation is much like an N-player Prisoners' Dilemma game.

The actors in the action situation have four characteristics. First is their information gathering and processing capabilities, bound by their experience, expertise, and capacity. Depending on the actor, some information will be salient while other information is "noise." Second, the actors are characterized by a set of preferences. They may be utility-maximizers or they may be satisficers; they may be risk-tolerant or risk-averse; they may prefer to cooperate or compete; they may value different outcomes in different ways. Third, actors employ decision criteria to select a course of action. Those decision criteria may vary in their degree of rationality or may be subject to some of the biases presented earlier. They may employ heuristics and simple frameworks or they may employ more sophisticated criteria. They may decide based on appropriateness or based on outcome. The combination of the actor's characteristics and the characteristics of the action situation determine the actor's strategy at a given point in the scenario. Defense acquisition actors include program managers, independent testers, budget officials, operational commanders, and others. At the individual level, a given military officer may rotate between those positions during a career.

It was noted earlier that there are external factors affecting the action arena. Those include rules-in-use, the attributes of the community, and the attributes of the physical world.

Rules-in-use or "working rules" are those that are actually considered when taking action. Ostrom describes them as "the set of rules to which participants would make reference if asked to explain and justify their actions to fellow participants."[36] Thus, rules-in-use may not conform to the formal standard operating procedures, regulations, and laws that are supposed to drive behavior; instead, they are the rules informed by such formal prescriptions, but modified by the norms of the community or communities the actor represents. In an acquisition context, rules-in-use capture not what the regulations say a program manager should do, but what CAPT John Doe—a naval officer, an aviator, a member of a particular systems command and PEO, who happens to be a program manager—thinks ought to be done. The actor's assessment of the expected payoff of an action includes any rewards for following rules and sanctions for violating them.

Rules come in three basic types: those that prohibit action, those that require action and those that permit action. There are also seven configurations of rules, according to Ostrom: rules for exit and entry, position, scope, authority, aggregation, information, and payoffs.[37] As the aim of this paper is to improve acquisition outcomes through effective policy interventions, policy-makers would be well-served to understand the various types of rules and how they impact the choices of actors.

Further affecting the action arena are the characteristics of the physical and political world in which, and about which, the actions take place. These attributes determine what actions and outcomes are even possible. Defense budgets, for example, are not solely the creation of the Defense Department, but are heavily influenced by external actors and events such as congressional budget processes and military operational contingencies. Lastly, the action arena is influenced by the attributes of the community. It was already noted that the

rules-in-use are affected by the community but so too are the strategies, preferences, and desired outcomes. The response of the community determines what behaviors are acceptable. They determine the degree of homogeneity of preferences and values among the actors.[38]

Action arenas are often interconnected. There may be a set of serially connected arenas of incremental decisions where the output of one arena becomes information available to another, or changes the payoffs in another, or establishes new rules for another. The latter example is common in hierarchical organizations, such as the DoD. An action arena at a high level of the organization that determines questions of process or provides guidance on organizational objectives becomes a boundary condition for an action arena at a lower level. Ostrom describes three levels of rule-making: *operational* rules that directly affect routine decisions, *collective-choice* rules that affect operational activities by determining who is eligible to participate and the rules for changing operational rules, and *constitutional-choice* rules that affect who and how collective-choice rules are made.[39] Vaughn noted that culture was a mediating mechanism between layers;[40] the IAD framework permits such layered analysis.

The Value of the Framework

The framework permits the application or testing of individual and group behavior theories. It permits the analysis of action scenarios across multiple layers. The interconnectedness of action arenas and rules makes the IAD framework useful to designing, testing, and studying the effects of policy prescriptions since those prescriptions normally take the form of new collective-choice or operational rules. How does it do that? The framework facilitates the prediction of outcomes by either modeling structured, predictable situations, or by inferring outcomes from lessons learned in field research.

The framework has been successfully employed to study the management of common pool resources and government budgets can be considered common pool resources.[41] It has been used in other government applications such as the study of corruption, mentioned earlier, and to examine the allocation of health resources in state governments. There is ample evidence to suggest it should also apply to defense acquisition.

In a defense acquisition cost growth context, possible research questions the framework can address include:

- Are resource, cost, and schedule decisions affected by the presence of non-rational biases, such as prospect theory would lead one to expect?
- Are resource allocation decisions affected by Thaler's "mental accounting"?
- What heuristics and frames are used by decision-makers?
- What preferences do the decision-makers bring to the action arena? Do they seek increasing budgets, sufficient budgets, or balanced budgets? How do they differ among roles?
- What rules-in-use exist that contravene the prescribed rules? Is "strategic misrepresentation" considered deviant? If so, how is it justified and censured?
- What action arenas determine the rules for the resource allocation arena?
- What changes in strategy occur in successive rounds as knowledge of program performance increases? Does that differ if the program is successful or unsuccessful?

A Suggested Research Agenda

In December 2007, the Undersecretary of Defense (Acquisition, Technology, and Logistics) tasked the Defense Science Board to look at human dynamics in warfare. The tasking memo created a Task Force on Understanding Adversaries because the DoD "needs

to understand the adversary and host population social structure, culture, motivations, beliefs and interests that contribute to behavioral actions and responses. This understanding is necessary to recognize behavioral patterns and gain influence in interactions."[42] If it is necessary to understand such factors to predict and influence behavior and response among the U.S.'s adversaries, does it not stand to reason that such factors must also be explored to understand and influence behavior among the actors in other contexts, such as defense acquisition?

Just as the DSB noted the insufficiency of the DoD's capabilities with respect to human dynamics—"outdated and insufficient training of military personnel and key advisors […] with respect to cultural studies, dynamic network analysis, and human dynamic models and simulations"[43]—gaps remain in the body of body of knowledge concerning the management of defense acquisition, including an understanding of the institutional forces that affect acquisition outcomes. A parallel task force for the understanding of human dynamics in defense acquisition could specifically map cultural forces and rules-in-use, using computational and laboratory tools to analyze the dynamics of the processes that define, fund, and manage acquisition programs. Without such understanding, effective policy interventions will remain elusive. The DSB asserts that "cultural insensitivity is militarily dysfunctional;"[44] it is also managerially dysfunctional. The field of organizational behavior has long linked the understanding of organizational culture to performance.[45]

What follows is the outline of a research agenda that should begin to fill the gap in knowledge. The agenda consists of both field work and computational/laboratory experimentation through models. The field work consists of qualitative research to increase understanding of institutional factors such as rules-in-use and community norms. Such

understanding is then used to create models that represent current environments and behavior. Those models are then taken to the field for validation. Upon validation, models are used to assess the likely impact of changes to exogenous factors, *viz.* new rules. Such experimentation allows the policy-setters to test the efficacy and to assess the secondary effects of policy options.

Field Research

Field research is necessary for three reasons. First, while there are extant studies on the culture of the military, there are not studies (to the author's knowledge) on the culture of defense requirements generation and validation, defense acquisition, or defense programming and budgeting. Employing the IAD framework can generate research questions about the institution of defense acquisition in manageable segments of work. Data can be collected about defense acquisition and analyzed within the elements of the IAD framework. Research questions to be answered by field work may include:

- According to the actors, what action arenas are most salient in affecting cost growth? (E.g., are the compromises inherent in building the defense budget more influential than the stature of an independent cost estimate?)
- What are the rules-in-use for a given action arena? (E.g., if decisions are made to underfund or underestimate the cost of a program, how is that justified?)
- To what communities are the actors beholden? (E.g., does affiliation with a particular military department affect a person's decisions on joint programs?)
- What incentives, rewards, or sanctions do the various communities use to enforce the rules? (E.g., are future promotions for officers based on the prestige of programs, the

mere fact that a person has acquired program management experience, or the performance of the program?)

- How are decision-makers affected by the multiple roles in which they serve? (E.g., what does it mean to be a program manager or resource sponsor who is also an aviator or submariner?)

Second, field work is necessary for collecting data to test hypotheses about defense acquisition that stem from theories of individual and group behavior that originated in different contexts:

- From behavioral finance, do budget reallocation decisions by resource managers in the DoD typify the mental accounting behaviors theorized by Thayer? Is the tendency to accept risk in some areas and not others consistent with Kahneman and Tversky's prospect theory?
- From group decision-making, are decisions affecting cost and funding based on their appropriateness, as March suggests, or based on expectations of utility-maximizing outcomes? What are the mental models and heuristics that guide information search, interpretation, and decisions?
- From organizational failure, do particular programs exhibit the factors associated with permanent failure that Meyer and Zucker documented, and, if so, do they follow a similar process? Does strategic misrepresentation occur in defense acquisition like it does in municipal public works projects, as demonstrated by Flyvbjerg's studies?

Both the first and second reasons for field work generate a level of external validity as the research moves into the laboratory and computational environments. The actual behaviors and rules-in-use uncovered in the field should be used to construct models of

organizational behavior. The laboratory and computational experimentation is described in the next section, but it is in that environment where alternative policy prescriptions can be assessed for their likely impact.

The third reason for field research is to validate the predictions that result from computational and laboratory experimentation. As promising policies are developed in the laboratory, they should be taken back to the field for validation. This can occur prospectively by surveying actors associated with defense acquisition to gauge the policies' face validity. This can also occur retrospectively after policies are enacted to assess whether the model accurately predicted the outcomes. Depending upon the materiality of the policy change, the models may need to be updated.

Experimental and Computational Research

Earlier in this paper, a comparison was made between the IAD framework as applied to common pool resource decision-making and an N-player, multi-round, Prisoners' Dilemma (PD) game. PD games have long been studied in laboratory settings and a strength of the IAD framework is that it, too, lends itself to such modeling, simulation, and gaming. In the book, *Rules, Games & Common-Pool Resources*, Ostrom et al. show how gaming can be used to understand actor strategies and institutional forces. They further show how gaming can be used to hypothesize and test the effects of rule changes on the structure and outcomes of action situations.[46]

Such modeling and gaming is not unique to the IAD framework and has become widely accepted in related domains. In the seminal issue of the journal *Computational and Mathematical Organization Theory*, Carley describes such work as focusing "on developing and testing organizational theory using formal models. The community shares a theoretical

view of organizations as collections of processes and intelligent adaptive agents that are task oriented, socially situated, technologically bound, and continuously changing."[47]

Carley summarized the state-of-the-art use of computational modeling for understanding social behavior and concluded that there are "a plethora of tools with impressive interfaces but little theoretical power"[48] It is important that any model created to support defense acquisition first begin with a solid theoretical foundation to inform its design. Carley provides a set of model design considerations that are beyond the scope of this paper but would be invaluable to one who would pursue this line of research. She also emphasizes the utility of such models for decision support and assessing the potential impacts of policy decisions in a cost-effective and timely manner.

Other applications of computational tools and techniques for understanding organizational behavior are relevant to a study of defense acquisition. The Virtual Design Team model created at Stanford University models complex engineering projects, not unlike defense acquisition projects. The model is based in contingency theory and adopts an information processing view of the actors and their interactions in a complex, multidisciplinary series of tasks.[49] The Stanford team has begun to explore the effects of culture on project performance.[50] The Virtual Design Team model has already been adapted to military use by the Center for Edge Power (CEP). The CEP has adapted the models to increase understanding of network-centric command and control structures.[51]

Conclusion

Tools of computational modeling currently exist to create a new level of understanding of the dynamics of defense acquisition. This paper outlines an agenda for research that would employ such tools in conjunction with a proven framework that

incorporates variables that have been omitted in past studies and are grounded in the theories of social science. The goal is to understand the institutional and cultural factors that lead to the types of decisions that too-often result in cost growth in defense acquisition projects. New policy prescriptions based on existing knowledge have not solved the problem; perhaps taking a rigorous look at additional factors will yield fresh insights into an old problem.

With greater understanding through field work, new rule sets can be hypothesized and tested in a computational or laboratory setting to see how behaviors, and ultimately outcomes, are affected. Such tests can be done in a timely and cost-effective manner without creating churn, confusion, or change-weariness within the acquisition workforce. Prospective rules that are found to reinforce the status quo in an experiment should be abandoned; those that offer the greatest promise of successful reform should be enacted. Understanding the behaviors of the actors in defense acquisition, and—more importantly—how those behaviors would change in the face of new rules, should make policy-making more effective. Effective in this case means a portfolio of programs that with increasing frequency meet warfighter requirements within cost and schedule parameters.

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